CLAIMS

1. A component mounting apparatus comprising: an X-Y robot (120) that has a component holding member (1361) for holding an electronic component (62), for mounting the held electronic component in a component placing position of a circuit board (61) after moving in an X-axis direction (51) and a Y-axis direction (52) that are perpendicular to each other; a fixed board recognition camera (140) that is provided for the X-Y robot, for picking up an image of a board mark on the circuit board; and a component recognition camera (150) for picking up an image of the electronic component held by the component holding member,

the apparatus comprising:

a camera reference mark (160) arranged in vicinity of the component recognition camera; and

a control unit (170) for correcting the component placing position based on position information of the camera reference mark obtained by picking-up the camera reference mark by means of the board recognition camera.

2. The component mounting apparatus as claimed in claim 1, further comprising an integrally structured component mounting apparatus chassis (110), wherein

the X-Y robot comprises two identical Y-axis robots (121) arranged mutually parallel along the Y-axis direction and one X-axis robot (131) arranged along the X-

axis direction perpendicular to the Y-axis robots, each of the Y-axis robots has a Y-ballscrew structure (122) that is formed directly on the component mounting apparatus chassis, for linearly thermally expanding and contracting only in the Y-axis direction with one end (122a) served as a fixed end and the other end (122b) served as a support end and moving the X-axis robot in the Y-axis direction, and the X-Y robot thermally expands and contracts linearly along the X-axis direction and the Y-axis direction.

3. The component mounting apparatus as claimed in claim 2, wherein the X-axis robot comprises an X-frame (132) that has both ends fixed to the ballscrew structure provided for each of the Y-axis robots and an X-ballscrew structure (133) which is formed on the X-frame, for thermally expanding and contracting linearly only in the X-axis direction with one end (133a) served as a fixed end and the other end (133b) served as a support end, receiving a component placing head (136) provided with the component holding member, and moving the component placing head in the X-axis direction, and the X-Y robot having the X-axis robot thermally expands and contracts linearly along the X-axis direction and the Y-axis direction.

4. The component mounting apparatus as claimed in claim 3, wherein the X-frame comprises: a support guide member (131) that is attached to the X-frame along the X-

axis direction, supporting the component placing head slidably in the X-axis direction and made of a material different from that of the X-frame; and a deformation prevention member (138), which is attached to the X-frame along the X-axis direction opposing the support guide member with interposition of the X-frame, for preventing the deformation of the X-frame, which is made of the same material as that of the support guide member.

5. The component mounting apparatus as claimed in claim 4, wherein the component placing head comprises a plurality of the component holding members, a holding member-driving source (1362) for moving the component holding members in a Z-axis direction (53) perpendicular to the X-axis direction and the Y-axis direction, that is independently provided for each the component holding members to reduce generation of heat of the holding member-driving source.

6. The component mounting apparatus as claimed in any one of claims 1 through 5, wherein the camera reference mark is arranged at the same height position as that of the circuit board when the board recognition camera picks up the board mark on the circuit board in the Z-axis direction (53) perpendicular to the X-axis direction and the Y-axis direction.

7. The component mounting apparatus as claimed in

any one of claims 1 through 5, wherein a plurality of the component recognition cameras are provided and the camera reference marks are provided adjacently to the respective component recognition cameras.

8. The component mounting apparatus as claimed in claim 1, wherein the X-Y robot has a relative position immovable to the component holding member and the board recognition camera and thermally expands and contracts linearly along the X-axis direction and the Y-axis direction.

9. The component mounting apparatus as claimed in claim 8, further comprising a component mounting apparatus chassis (110), wherein the component mounting apparatus chassis is formed into an integrated structure by casting and causes linear thermal expansion and contraction in the X-Y robot.

10. The component mounting apparatus as claimed in claim 9, wherein the X-axis robot comprises an X-frame (132) that has both ends fixed to the ballscrew structure provided for each of the Y-axis robots, the X-frame has a support guide member (131) attached to the X-frame along the X-axis direction, and a deformation prevention member (138) that is attached to the X-frame along the X-axis direction opposing the support guide member with interposition of the X-frame, for preventing the

deformation of the X-frame due to heat, and the X-axis robot has a relative position immovable to the component holding member and the board recognition camera.

11. The component mounting apparatus as claimed in claim 10, wherein the X-axis robot further comprises an X-ballscrew structure (133) which is formed on the X-frame, for thermally expanding and contracting linearly only in the X-axis direction with one end (133a) served as a fixed end and the other end (133b) served as a support end, receiving a component placing head (136) provided with the component holding member, and moving the component placing head in the X-axis direction, the component placing head comprises a plurality of the component holding members, a holding member-driving source (1362) for moving the component holding member in the Z-axis direction (53) perpendicular to the X-axis direction and the Y-axis direction, that is independently provided for each the component holding members, and the relative position of the component placing head is immovable to the component holding member and the board recognition camera.

12. A component mounting method carried out by a component mounting apparatus that has a component holding member (1361) for holding an electronic component (62) and mounting the held electronic component in a component placing position of a circuit board (61) after moving in an

X-axis direction (51) and a Y-axis direction (52) that are perpendicular to each other, the method comprising:

picking-up an image of a camera reference mark (160) arranged adjacent to a component recognition camera (150) for picking up an image of the electronic component held by the component holding member, by means of a board recognition camera (140) for picking up an image of a board mark on the circuit board;

comparing position information of the camera reference mark obtained by the image-picking-up with preset reference position information to obtain a difference;

using the difference for correcting an amount of movement when the electronic component held by the component holding member is moved to the fixed component recognition camera (150) and the image of the electronic component is picked up; and

transferring and then placing the electronic component to a placing position on the circuit board after correcting an amount of displacement of the circuit board obtained by picking-up the image of the board mark by means of the board recognition camera after the image-picking-up of the electronic component by means of the component recognition camera.

13. The component mounting method as claimed in claim 12, wherein, when productive mounting operation is

interrupted, the image-picking-up of the camera reference mark is carried out immediately before restarting the productive mounting operation.

14. The component mounting method as claimed in claim 12 or 13, wherein, when the difference obtained by the image-picking-up is not smaller than a set value, the operation of the component mounting apparatus is stopped.

15. The component mounting method as claimed in any one of claims 12 and 13, wherein a positional relation between the component holding member and the board recognition camera, a positional relation between the component holding member and the component recognition camera, and a positional relation between the board recognition camera and the component recognition camera are preliminarily measured, and the measurement values are treated as preconditions for the correction of the component placing position.

16. The component mounting method as claimed in any one of claims 12 and 13, wherein, when a plurality of the component recognition cameras are provided and a plurality of camera reference marks are provided and if the difference obtained by image-picking-up one of the plurality of the camera reference marks is smaller than a set value, then the image-picking-up of the other camera reference marks is omitted.

17. The component mounting method claimed in claim 12 for placing the electronic component (62) held by the component holding member (1361) of a component holding head (136) movable with respect to a board holding device (165) in the component placing position of the component mounting circuit board (61) held by the board holding device, the method further comprising:

recognizing position coordinates of the placing region reference marks (201) arranged at regular intervals on a placing region reference mark recognition reference board (200) held by the board holding device in a state in which the placing region reference mark recognition reference board is held by the board holding device and positioned in the component placing region and then obtaining the position coordinate of each recognized placing region reference mark;

obtaining NC coordinates of the position coordinates of at least two board reference position calculation marks (201A, 201B) of the component mounting circuit board;

extracting placing region reference marks located near to the two board reference position calculation marks from among the recognized placing region reference marks;

obtaining an offset value of each placing region reference mark by subjecting the position coordinate of

each extracted placing region reference mark to coordinate transformation so that a correction value of the extracted placing region reference mark becomes zero or substantially zero;

recognizing at least two board reference position calculation marks of the component mounting circuit board held by the board holding device in a state in which the component mounting circuit board is held by the board holding device and positioned in the component placing region in place of the placing region reference mark recognition reference board and then obtaining the position coordinates of the recognized two board reference position calculation marks;

correcting the NC coordinates of the two board reference position calculation marks based on the position coordinates of the obtained two board reference position calculation marks;

carrying out correction of the position coordinates of the component placing position based on the offset value of the placing region reference mark located nearest to the recognition camera provided for the component holding head when the component held by the component holding head is positioned above the component placing position of the component mounting circuit board; and thereafter placing the component in the component

placing position based on the corrected position coordinates of the component placing position.

18. The component mounting method as claimed in claim 17, wherein,

when obtaining the offset value of each placing region reference mark by subjecting the position coordinates of each extracted placing region reference mark to coordinate transformation so that the correction value of the extracted placing region reference mark located near to the two board reference position calculation marks becomes zero or substantially zero,

the offset values of placing region reference marks are obtained by subjecting the position coordinates of the extracted placing region reference marks to coordinate transformation, the coordinate transformation being carried out by rotating and shifting a graphic line that connects the extracted placing region reference marks so that each of the correction values of the extracted placing region reference marks located near to the two board reference position calculation marks becomes zero or substantially zero, so that the positional coordinates of the extracted placement region reference mark is subjected to coordinate transformation.

19. The component mounting method as claimed in claim 17 or 18, wherein,

when obtaining the offset value of each placing region reference mark by subjecting the position coordinate of each extracted placing region reference mark to coordinate transformation so that the correction value of the extracted placing region reference mark located near to the two board reference position calculation marks becomes zero or substantially zero,

the offset value of each placing region reference mark is obtained by calculating the correction value in at least one direction of the X-direction of the board holding device and the Y-direction perpendicular to the X-direction from the extracted placing region reference mark, obtaining an inclination of the reference board, and subjecting the position coordinate of each extracted placing region reference mark to coordinate transformation, the coordinate transformation being carried out so that the correction value of the extracted placing region reference mark becomes zero or substantially zero.

20. The component mounting apparatus claimed in claim 1 for placing the electronic component (62) held by the component holding member (1361) of the component holding head (136) movable with respect to the board holding device by means of the X-Y robot in the component placing position of the component mounting circuit board (61) held by the board holding device (165), wherein

the board recognition camera (140) is provided for the component holding head supported by the X-Y robot and recognizes the position coordinate of the placing region reference mark (201) arranged at regular intervals on a placing region reference mark recognition reference board (200) held by the board holding device in a state in which the placing region reference mark recognition reference board is held by the board holding device and positioned in the component placing region,

the apparatus further comprises an operation unit (171) for: obtaining the position coordinate of each placing region reference mark from a recognition result of the placing region reference mark recognized by the board recognition camera; obtaining a difference between the NC coordinates and the position coordinates of the respective placing region reference marks as a correction value; extracting placing region reference marks located near to the two board reference position calculation marks from among the recognized placing region reference marks based on the NC coordinates of the position coordinates of at least two board reference position calculation marks of the component mounting circuit board; obtaining an offset value of each placing region reference mark by subjecting the position coordinates of the extracted placing region reference mark to coordinate transformation so that the

correction value of the extracted placing region reference mark becomes zero or substantially zero; recognizing at least two board reference position calculation marks of the component mounting circuit board held by the board holding device in a state in which the component mounting circuit board is held by the board holding device and positioned in the component placing region in place of the placing region reference mark recognition reference board; obtaining the position coordinates of the recognized two board reference position calculation marks; and correcting the NC coordinates of the two board reference position calculation marks based on the position coordinates of the obtained two board reference position calculation marks, and

the control unit (170) corrects the position coordinates of the component placing position based on the offset value of the placing region reference mark located nearest to the recognition camera provided for the component holding head when the component held by the component placing head is positioned above each component placing position of the component mounting circuit board, and thereafter places the component in the component placing position based on the corrected position coordinate of the component placing position.

21. The component mounting apparatus as claimed in claim 20, wherein, when obtaining the offset value of each

extracted placing region reference mark by subjecting the position coordinate of the extracted placing region reference mark to coordinate transformation so that each of the correction values of the extracted placing region reference marks located near to the two board reference position calculation marks becomes zero or substantially zero, the operation unit obtains the offset values of placing region reference marks by subjecting the position coordinate of the extracted placing region reference marks to coordinate transformation, the coordinate transformation being carried out by rotating and shifting a graphic line that connects the extracted placing region reference marks so that each of the correction values of the extracted placing region reference marks located near to the two board reference position calculation marks becomes zero or substantially zero.

22. The component mounting apparatus as claimed in claim 20 or 21, wherein, when obtaining the offset value of each extracted placing region reference mark by subjecting the position coordinate of the extracted placing region reference mark to coordinate transformation so that each of the correction values of the extracted placing region reference marks located near to the two board reference position calculation marks becomes zero or substantially zero, the operation unit obtains the correction value in at

least one direction of the X-direction of the board holding device and the Y-direction perpendicular to the X-direction from the extracted placing region reference mark, obtains an inclination of the reference board, and obtains the offset value of each placing region reference mark by subjecting the position coordinate of the extracted placing region reference mark to coordinate transformation so that the correction value becomes zero or substantially zero.

23. The component mounting apparatus as claimed in any one of claims 20 and 21, comprising an X-Y robot (120) that has two Y-axis robots (121) arranged mutually parallel along the Y-axis direction (52) and one X-axis robot (131) that is arranged on the two Y-axis robots movably along the X-axis direction (51) perpendicular to the Y-axis direction and movably supports the component holding head (136) along the X-axis direction, wherein the component holding head is made movable by the two Y-axis robots and the one X-axis robot in the X- and Y-axis directions with respect to the board holding device.

24. The component mounting apparatus as claimed in claim 23, wherein the component holding head (136) has a plurality of component suction nozzles (1361) that are each able to suck and hold the component and that are arranged along the X-axis direction, and the board recognition camera is arranged on the component holding head (136) so

that an image-pickup center of the board recognition camera (140) is positioned coaxially with a straight line that extends through a center of the plurality of component suction nozzles.